

COMPARATIVE STUDY OF MECHANICAL PROPERTIES OF DIFFERENT PLAIN WEAVE COTTON FABRICS

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ABSTRACT

Cotton is the king of textile fibers. It is one of the majorly used textile fiber for the production of apparel. 40 Ne, 60 Ne, and 80 Ne cotton yarns are selected to produce plain weave fabrics for the application of apparel. 40 Ne X 40 Ne, 60 Ne X 60 Ne, 80 Ne X 80 Ne, yarns with different ends per inch and picks per inch were used to produce plain weave fabrics. Fabric dimensional study, Tensile strength and elongation, Tearing strength, and fabric stiffness were studied. Shrinkage in warp way is more compare to weft direction of the fabrics. It is observed that whenever the EPI or PPI increase the Tensile strength, tearing strength and stiffness increases. Tensile strength, Tearing strength and fabric stiffness increase with increase in yarn cotton count.

KEY WORDS: Ends per Inch(EPI), Picks Per Inch (PPI), Dimensional Stability, Tensile Strength, Tearing Strength & Stiffness

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INTRODUCTION

Textile products are being produced for centuries for clothing purposes. The manufacturing technologies are modified and innovated based on the practical difficulties of manufacturing and invention on new fiber, knowledge had been passed transferred from generation to generation. Inventions new machines have changed the manufacturing technologies of Textile industries.

Simultaneously, the invention of new synthetic fibers such as Polyester, Nylon, Acrylic Etc, gave new avenues to use the synthetic fibers for apparel and industrial application (W. E. Morton and J. W. S. Hearle, 2008).

All the apparel products produced by utilizing natural and synthetic fibers are important for both aesthetic a functional aspects. The purpose of clothing is for protection same time it has to be comfortable and pleasant in look (Apurba Das and R. Alagiruswamy, 2010).

Cotton fiber has been used as natural and sustainable clothing. Till today there is no textile synthetic fiber is comparable to cotton fiber, due to its comfort properties.

Varieties of cotton fibers are grown for the uses of textiles. There are wide varieties of cotton commercial fabrics available for garment manufacturing. So, the selection of suitable fabric for casual and formal garments required to understanding of the properties which are important for apparels category.

Fabric properties are conveniently divided into different groups depending upon the end user requirements special properties may be considered and tests may be performed to assess these properties. In this study the properties which are requisite for cotton garments are considered and performed to assess the results.

Table 1: Fabric Details

Fabric Sample No	Count	EPI and PPI	Fabric Type
P1	40X40	92X88	Plain
P2	60X60	92X88	Plain
P3	80X80	92X88	Plain
P4	40X40	132X72	Plain
P5	60X60	132X108	Plain
P6	80X80	120X100	Plain

MECHANICAL PROPERTY

Fabric Dimensional Stability

In the garment industry shrinkage is one of the major quality problems facing from beginning of the process to the consumer. Dimensional stability test is conducted for the determination of dimensional changes of fabrics when subjected to home laundering procedures. The fabric specimens are tested by using the standard test method AATCC-135-2004. Ten readings were observed and tabulated. The average of the same has been tabulated for further interpretations.

Table 2: Dimensional Stability

Fabric Sample No.	Direction of the Test	Initial length Cms	Final Length cms	Fabric Shrinkage %
P1	Warp	25	24.2	3.2
	Weft	25	24.5	2.0
P2	Warp	25	24.4	2.4
	Weft	25	24.4	2.4
P3	Warp	25	24.3	2.8
	Weft	25	24.6	1.6
P4	Warp	25	24.3	2.9
	Weft	25	24.8	0.8
P5	Warp	25	24.3	2.9
	Weft	25	24.8	0.8
P6	Warp	25	24.5	2.0
	Weft	25	24.7	1.2

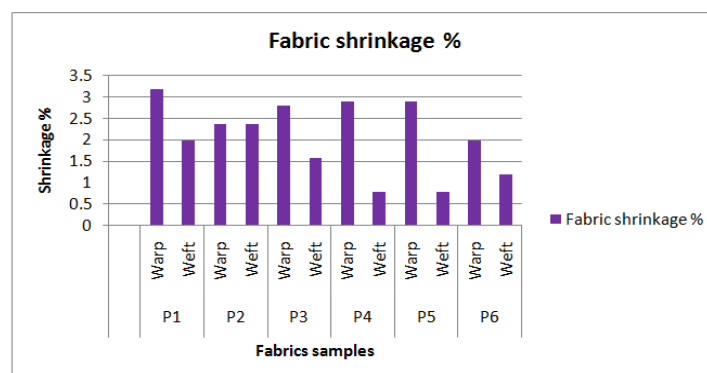


Figure 1: Dimensional Stability

Fabric Tensile Strength and Elongation

Test method covers the grab and modified grab test procedures for determining breaking strength and elongation of the fabrics (Saville.B.P.1999). A 100mm (4.0 inch) wide specimen is mounted centrally in clamps of tensile testing machine and a force applied until the specimen breaks. Values for the breaking force and elongation of the test specimen are obtained from the computer interfaced machine scales. The fabric specimens are tested by using the standard test method ASTM-D-5034.

Table 3: Fabric Tensile Strength and Elongation

Fabric Type	Tensile Strength at Break in kgf		Elongation %	
	Warp	Weft	Warp	Weft
P1	14.7	14.9	32.67	38.00
P2	14.1	10.8	23.33	36.00
P3	8.2	7.02	17.33	37.33
P4	30.3	14.4	38.00	35.33
P5	20.1	15.1	38.0	33.33
P6	11.7	7.6	24.67	36.67

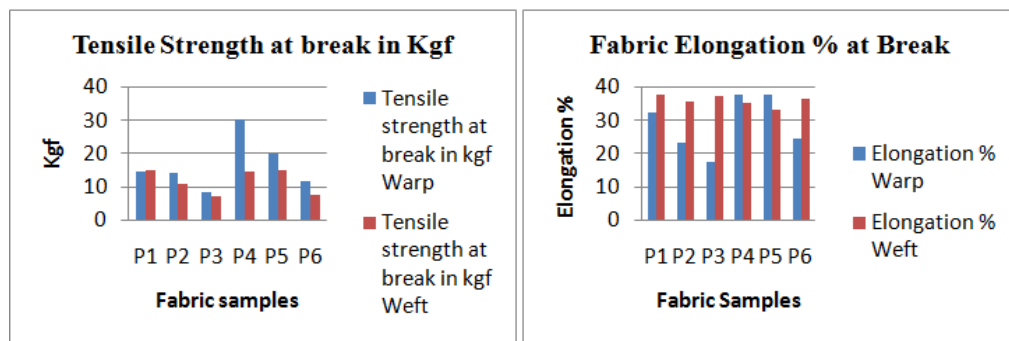


Figure 2: Fabric Tensile Strength and Elongation

Fabric Tearing Strength

Test method covers the determination of the force required to tear on single strip cut of a fabric and using a falling- pendulum type (Elmendorf) apparatus (Saville.B.P.1999). A slit is centrally precut in attest specimen held between two clamps and the specimen is torn affixed distance. The resistance to tearing is in part factored into the scale reading of the instrument and is computed from this reading and the pendulum capacity. The fabric specimens are tested by using the standard test method ASTM-D-1424. Ten readings were observed and tabulated. The average of the same has been tabulated for further interpretations.

Table 4: Fabric Tearing Strength

Type of Fabric	Tear Strength in kgf	
	Warp	Weft
P1	1.12	1.06
P2	0.90	0.80
P3	0.67	0.67
P4	1.47	1.45
P5	0.67	1.32
P6	0	0

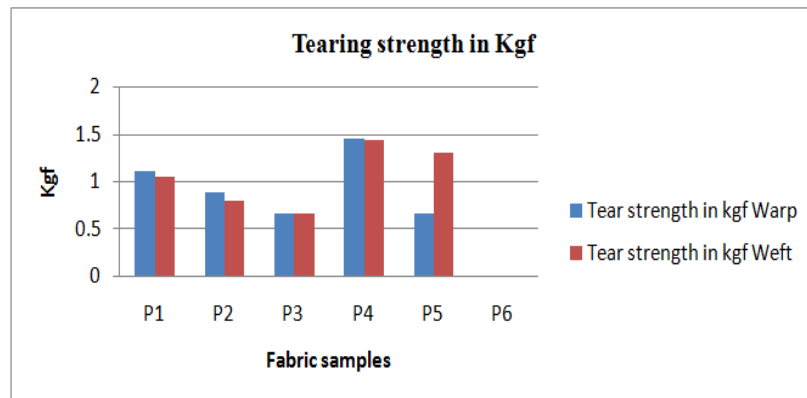


Figure 3: Fabric Tearing Strength

Fabric Stiffness

The bending length is dependent on the fabric weight (Saville.B.P.1999) and is therefore an important component of the drape of the fabric when it is hanging under its own weight the relationship among the length of the overhanging strip the angle that is bends to and the flexural rigidity G , of the fabric is a complex one which was solved empirically by pierce to give formula.

- **L** – Length of fabric projecting, **O** – Angle fabric bends and
- **M** – Mass per unit area

Cantilever test, employing the principle of cantilever bending of the fabric under its own mass. This test method covers measurement of stiffness properties of fabrics. Bending length of is measured as directed in the standard test method ASTM-D-1388 using Shirley stiffness tester and bending flexural rigidity and bending modulus were calculated. Ten readings were observed and tabulated. The average of the same has been tabulated for further interpretations

Bending Rigidity (Flexural Rigidity)

Flexural rigidity is the ratio of small change in bending moment per unit width of the material to the corresponding small change in curvature.

$$\text{Bending Rigidity } G = M \times C^3 \times 10^3$$

Where

- **C**- Bending length (cm) and
- **M**- Fabric mass per unit area (g/m³)
- **G**- Flexural rigidity.

Bending Modulus

The stiffness of the fabric in bending is dependent on its thickness; the thicker the fabric becomes stiffer.

$$\text{Bending Modulus} = 12 \times G \times 10^{-6} / T^3$$

T=Thickness of the fabric (cm).

Table 5: Bending Length, Flexural Rigidity and Bending Modulus

Fabric Sample No	Bending Length Warp	Bending Length Weft	Flexural Rigidity Warp	Flexural Rigidity Weft	Bending Modulus Warp	Bending Modulus Weft
P1	4.9	4.5	1247	966	381	295
P2	5.6	4.8	1352	852	824	519
P3	5.1	4.1	716	372	807	419
P4	4.1	4.5	827	1094	252	334
P5	5.1	5.3	1300	1459	888	996
P6	5.1	5.4	862	1024	971	1024

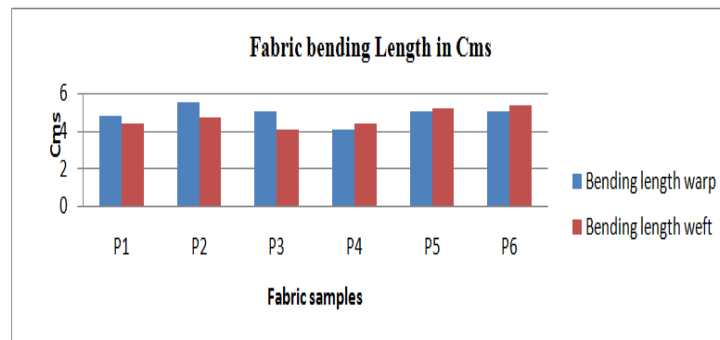


Figure 4: Bending Length of Fabrics

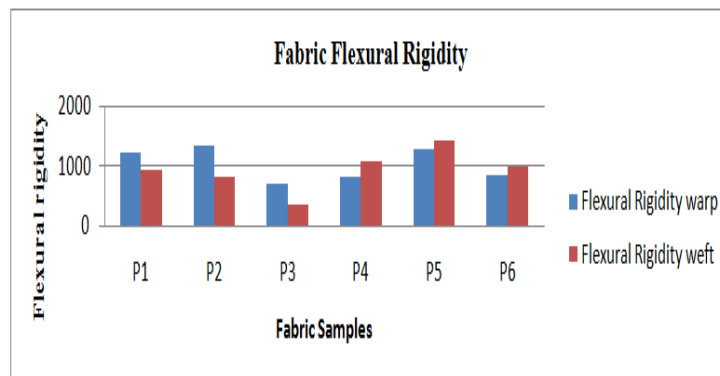


Figure 5: Fabric Flexural Rigidity

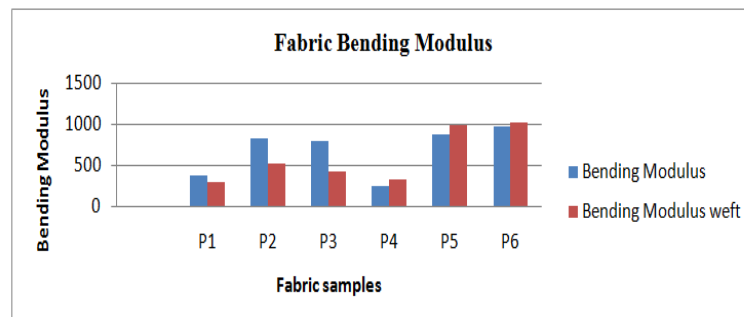


Figure 6: Fabric Bending Modulus

RESULTS AND DISCUSSIONS

MECHANICAL PROPERTIES

Dimensional Stability

Dimensional stability of the fabrics was calculated in warp and weft direction in terms of shrinkage percentage as shown in the table 2 and fig1. It is been observed that dimensional stability of all fabrics is good and are less than 3.5% and it is acceptable for the production of garments. Shrinkage is found more in warp way in all the fabrics. It is due the warp density is higher than the weft density.

Fabric Tensile Strength and Elongation

The results of tensile strength of fabrics is shown in the table3 and fig 2.The fabrics P4 and P5 shown higher tensile strength followed by P2,P1,. Warp way is higher than weft way .this is due to higher thread density. Tensile strength of P3 fabrics less compare to P1 and P2 fabrics due finer yarns were used in P3 fabrics. Elongation percentage of P4 and P2 is higher compare to other fabrics. Elongation of fabric in Warp way direction shows higher than weft way direction.

Tearing Strength

Tearing strength results of the fabrics is shown in table 4 &3.P1, P4 fabrics shows higher tearing strength compared to other fabrics. But in P6 both warp and weft tearing strength is less than 3.2 kg capacity. The samples are not considering as test values. The tensile properties of constituent fibers and yarns, yarn density, yarn twist and yarn count influence the tearing resistance.

Bending Rigidity

Results of bending rigidity of the fabrics are shown in table 5.and Fig: 4, 5 and 6. Fabric P1and P4 shows maximum value of flexural rigidity followed by P5, P2, and P1. AndP4 shows least value. Warp way is higher compared to weft way in P1, P2 P3,P4, and P6. This is because of twist in yarn.

Bending Modulus

The bending modulus is independent property of the dimensions of the fabric so that by analogy of the solid materials it is a measure of intrinsic stiffness. The bending modulus values of fabrics are calculated and shown in the table 5 and fig 6.The fabrics P6, P5, and P2 show maximum value followed byP3, P4, and P1.The bending modulus value depends on yarn parameters such as yarntwist, linear density and fabric thickness.

CONCLUSIONS

Dimensional stability of the all six types of cotton fabrics is good. it is acceptable for the production of garments.

P4 and P5 fabric with higher thread density shows higher tensile strength than other fabrics. The tensile properties of constituent fibers and yarns, yarn density, yarn twist and yarn count influence the Tensile and tearing strength.

Bending modulus values are depends on factors such as Twist of the yarn, density of yarn and fabric thickness and weave of the fabric

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